WaterSentry™: A Continuous Real-Time Water Monitoring Biosensor System*

E. Greenbaum[1], M. Rodriguez Jr[1]., S. McCarter[2], and A. Kassinos[2]

[1]Oak Ridge National Laboratory
Oak Ridge, Tennessee

[2]United Defense, LP
York, Pennsylvania

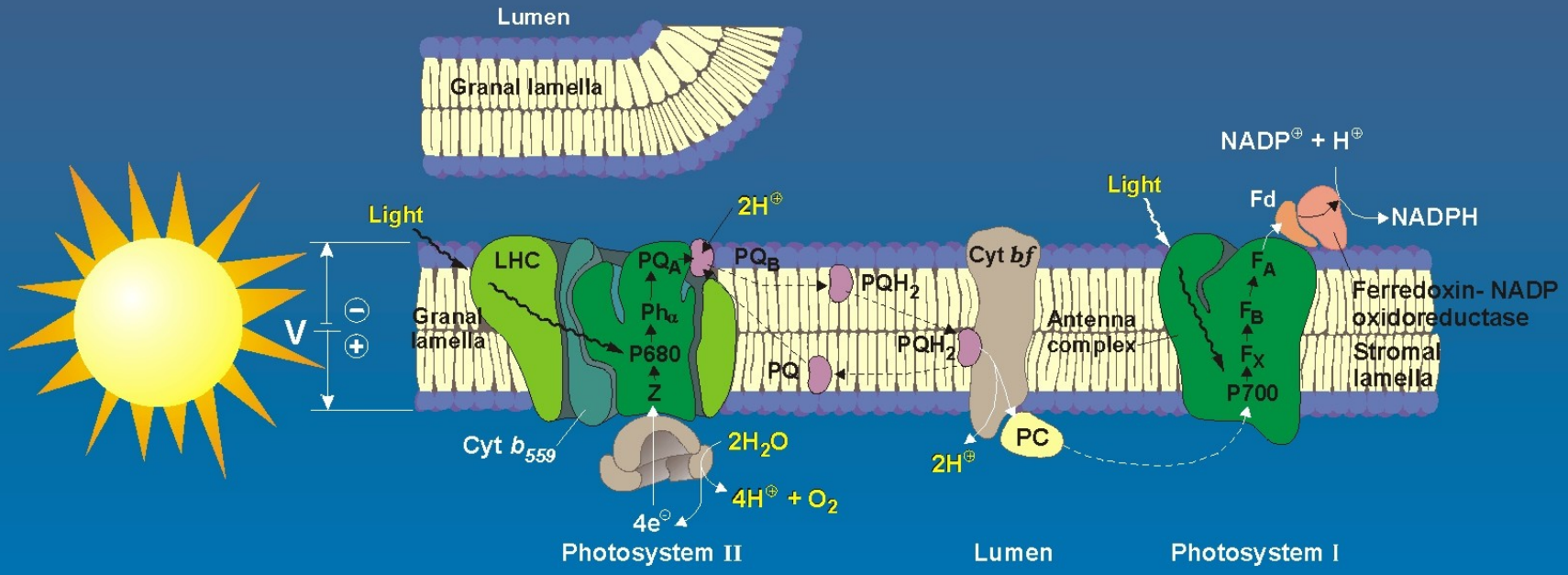
*Research supported by United Defense, LP

PROCESS DRAIN
WARNING

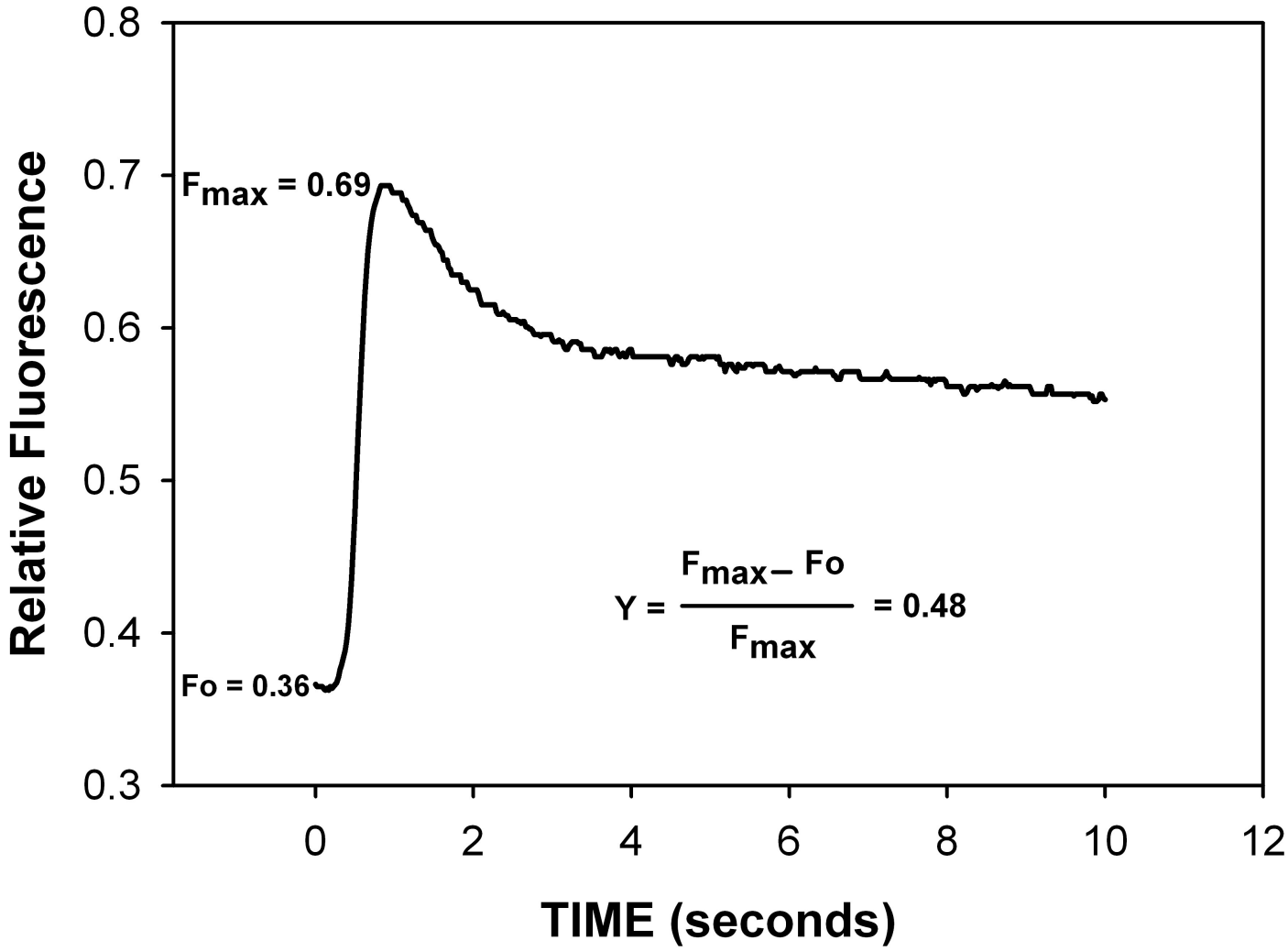
Oak Ridge, TN 37831 USA

DOE

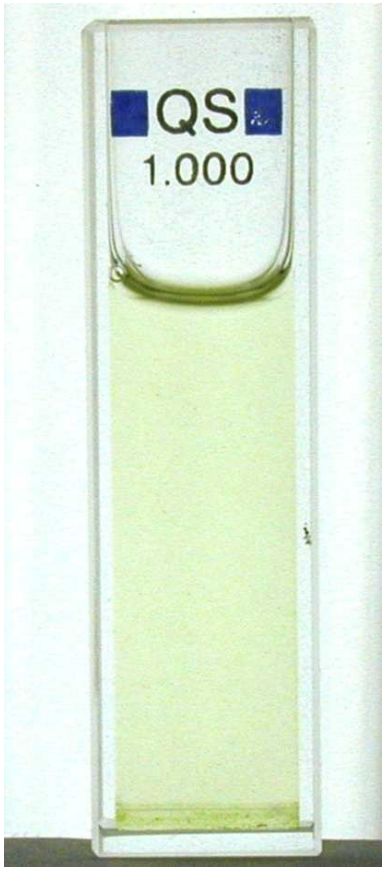
The Photosynthetic Membrane



Typical Fluorescence Induction Curve from Naturally-Occurring Algae in Untreated Clinch River Water



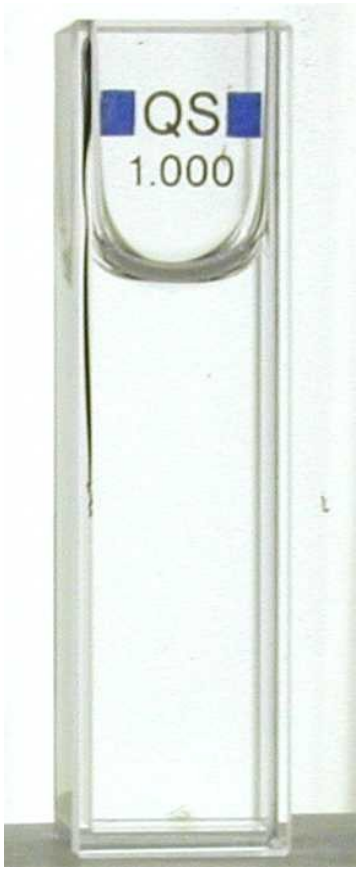
Microscopic Algae as Biosensors: Not visible to the naked eye at low chlorophyll concentrations



2 μg/ml

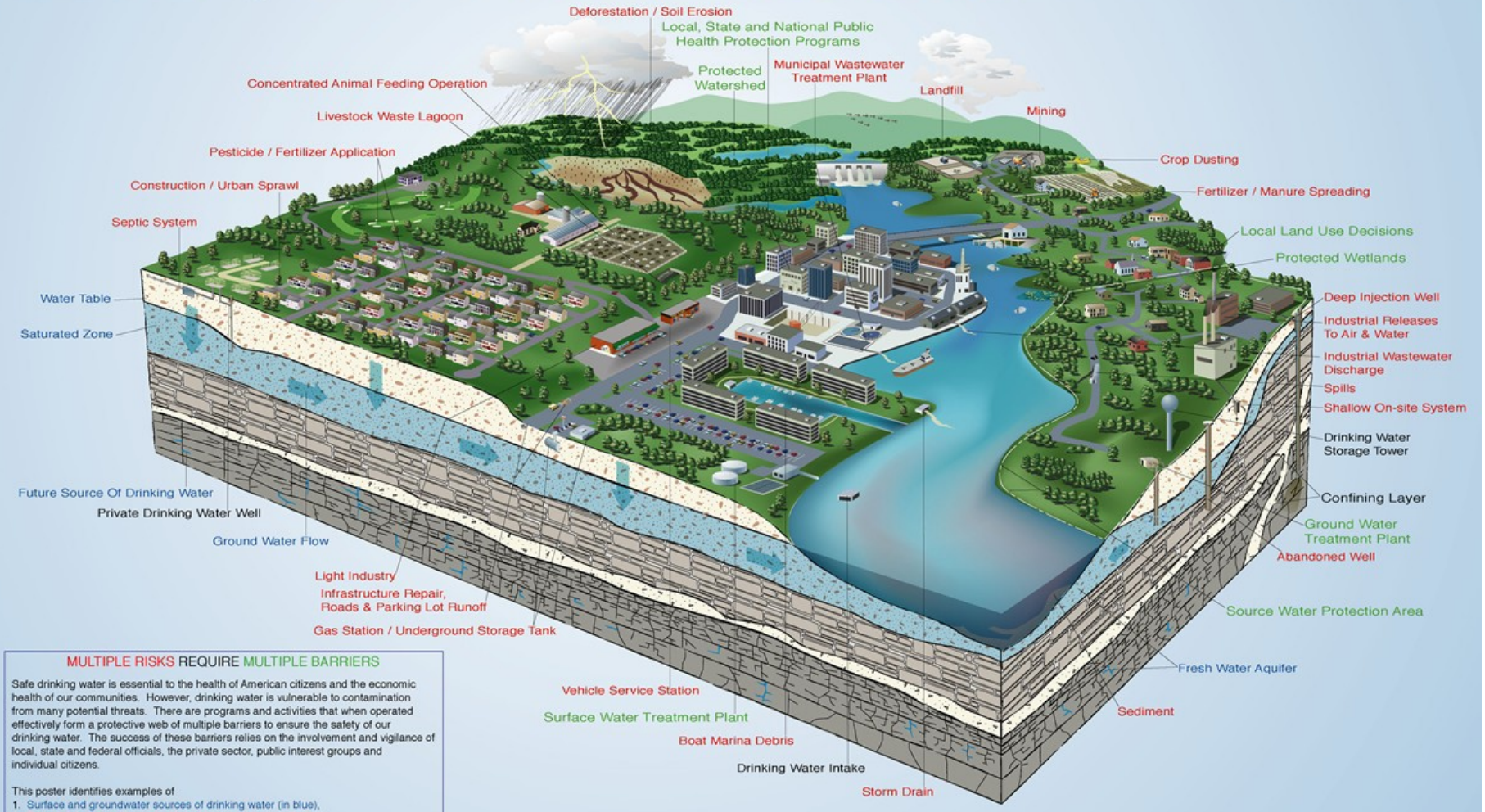
0.47 μg/ml

0.063 μg/ml



0.0063 μg/ml

Safe Drinking Water Act - Protecting America's Public Health



MULTIPLE RISKS REQUIRE MULTIPLE BARRIERS

Safe drinking water is essential to the health of American citizens and the economic health of our communities. However, drinking water is vulnerable to contamination from many potential threats. There are programs and activities that when operated effectively form a protective web of multiple barriers to ensure the safety of our drinking water. The success of these barriers relies on the involvement and vigilance of local, state and federal officials, the private sector, public interest groups and individual citizens.

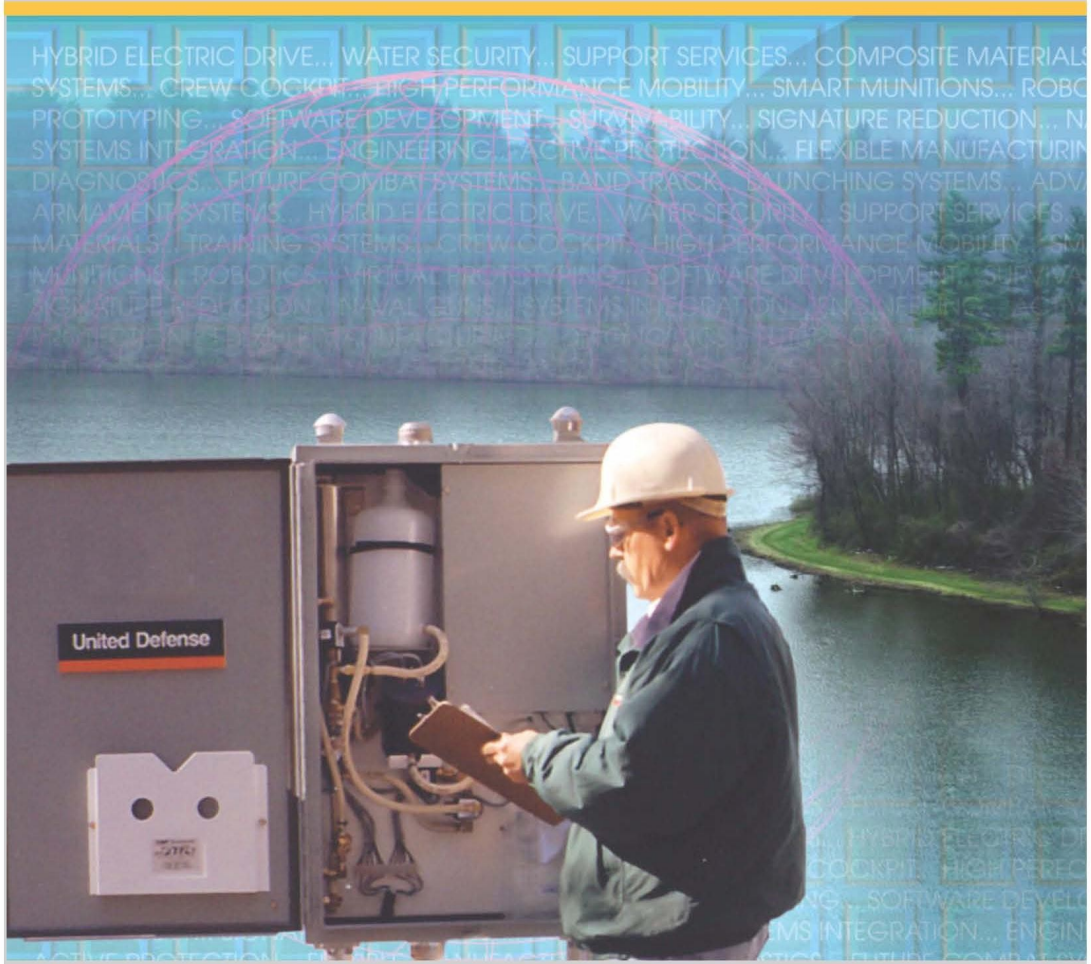
This poster identifies examples of

1. Surface and groundwater sources of drinking water (in blue),
2. Potential threats to those drinking water sources (in red), and
3. The multiple barriers that together protect our nation's public health (in green).
   - Risk Prevention Barrier
   - Risk Management Barrier
   - Risk Monitoring and Compliance Barrier
   - Individual Action Barrier

Safe Drinking Water Hotline – (800) 426-4791 Safewater Web Site – www.epa.gov/safewater

EPA
United States Environmental Protection Agency
EPA 816-H-02-003
January 2002

HOMELAND DEFENSE



Defending Our Nation's Water Supplies. The United Defense WaterSentry™ system provides first alert toxin detection for homeland security, military and other civilian applications. The WaterSentry™ security alert system conducts automated around-the-clock testing for waterborne toxins, guarding our vital drinking water supplies.

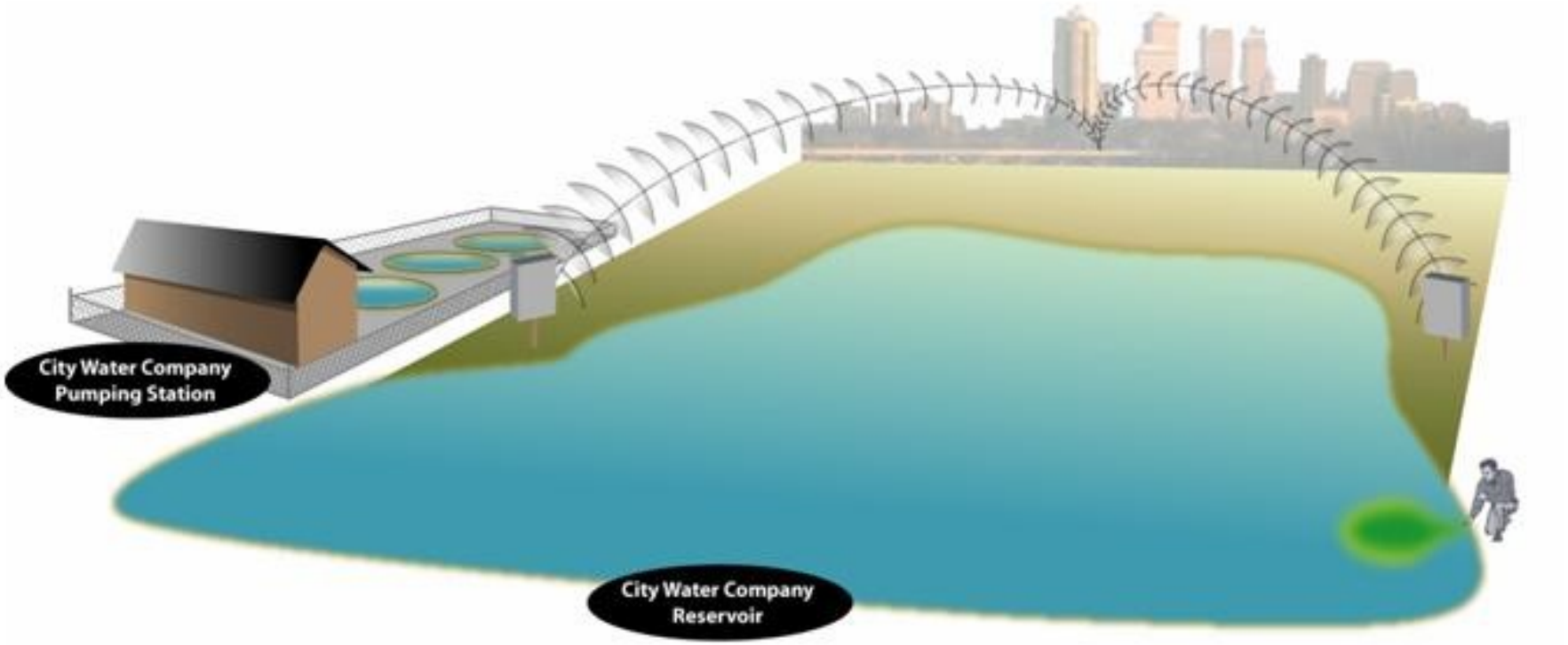
United Defense

Algae are found in all sun exposed bodies of water.

Water enters the test unit where a state of the art sensor measures the algal fluorescence.

Multiple variables are used to determine if a toxin is present in the water.

Messages
OK
Test Unit Status
Test Unit
Alert Condition
Current Yield
Previous Yield
Bag #1
Bag #2
Ambiguous Alert
SHUTDOWN
NEXT TEST CYCLE: 00:04

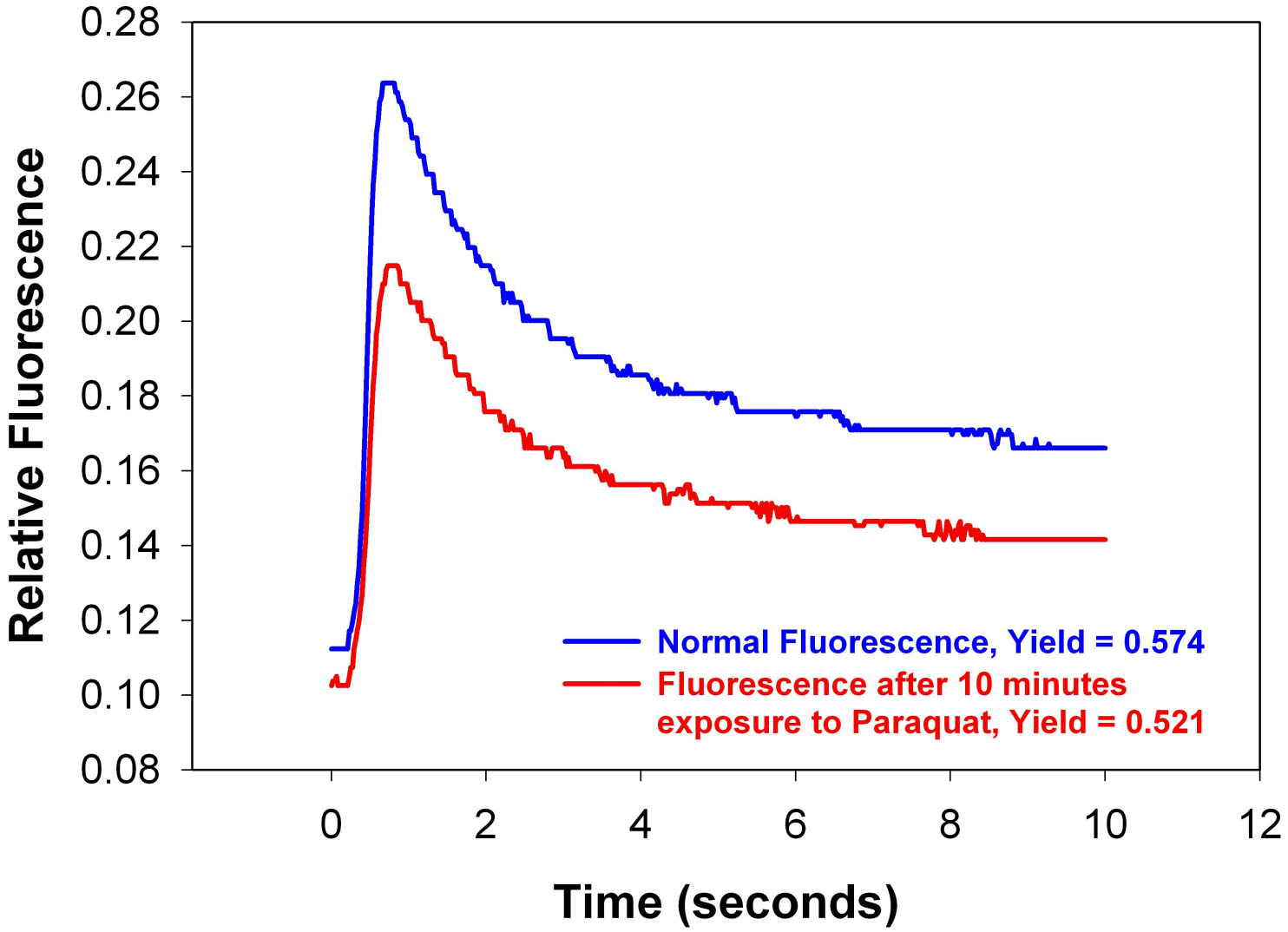

City Water Company
Pumping Station
City Water Company
Reservoir

Selected Waterborne Agents Grouped by Class

Herbicides	Paraquat: irreversible lung damage, pulmonary fibrosis; DCMU (Diuron): electron transport blocker, used in conjunction with Agent Orange
Nerve Agents	Organophosphorous Compounds – Acetyl choline esterase inhibitors: Methyl Parathion (Insecticide)
Blood Agents	Interfere with body's oxygen supply: Cyanide

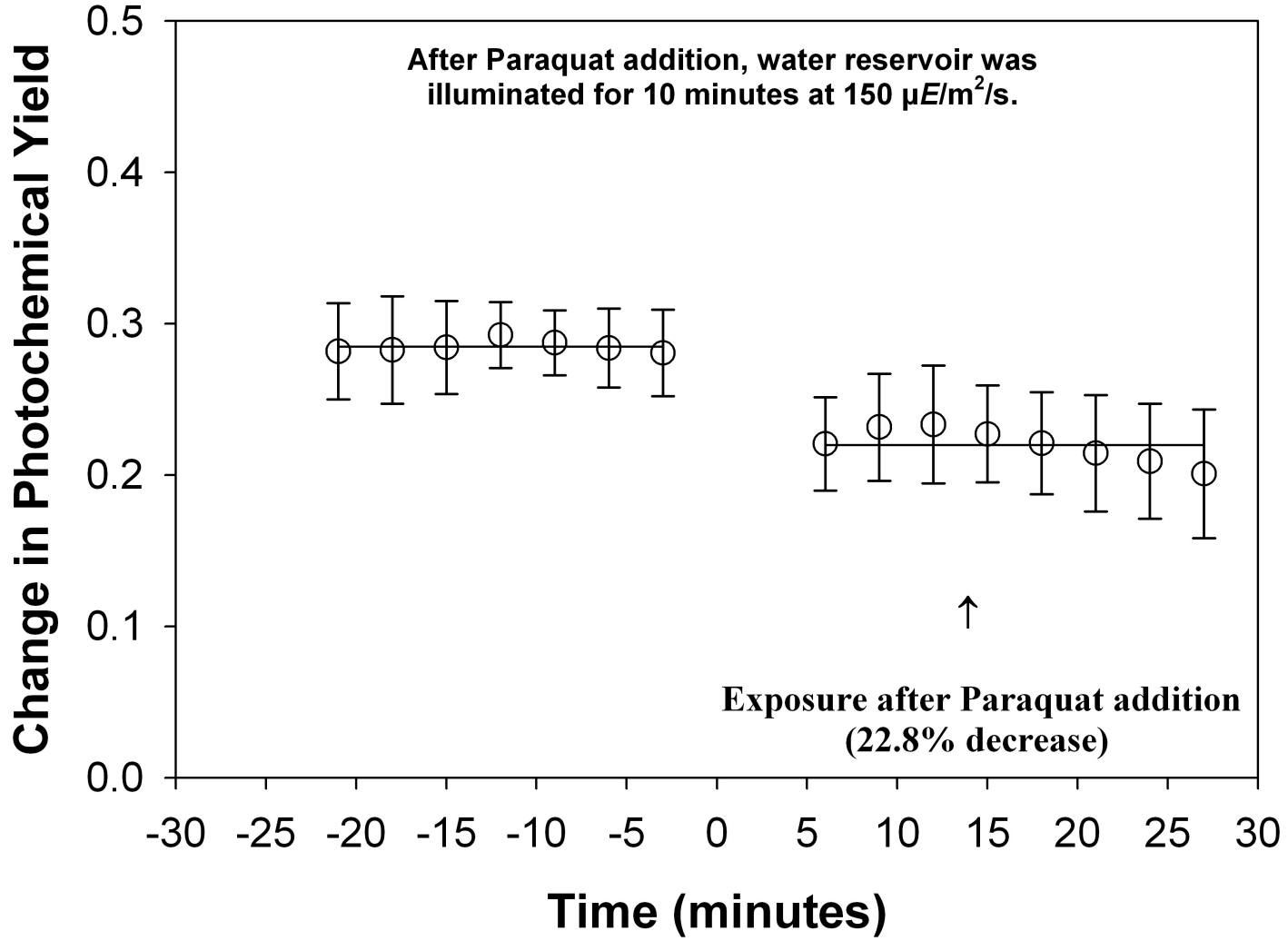
Effect of 6 ppm Paraquat on Clinch River's Naturally-Occurring Algae

EPA Health Advisory (10-Kg Child, 1 day) = 0.1 ppm



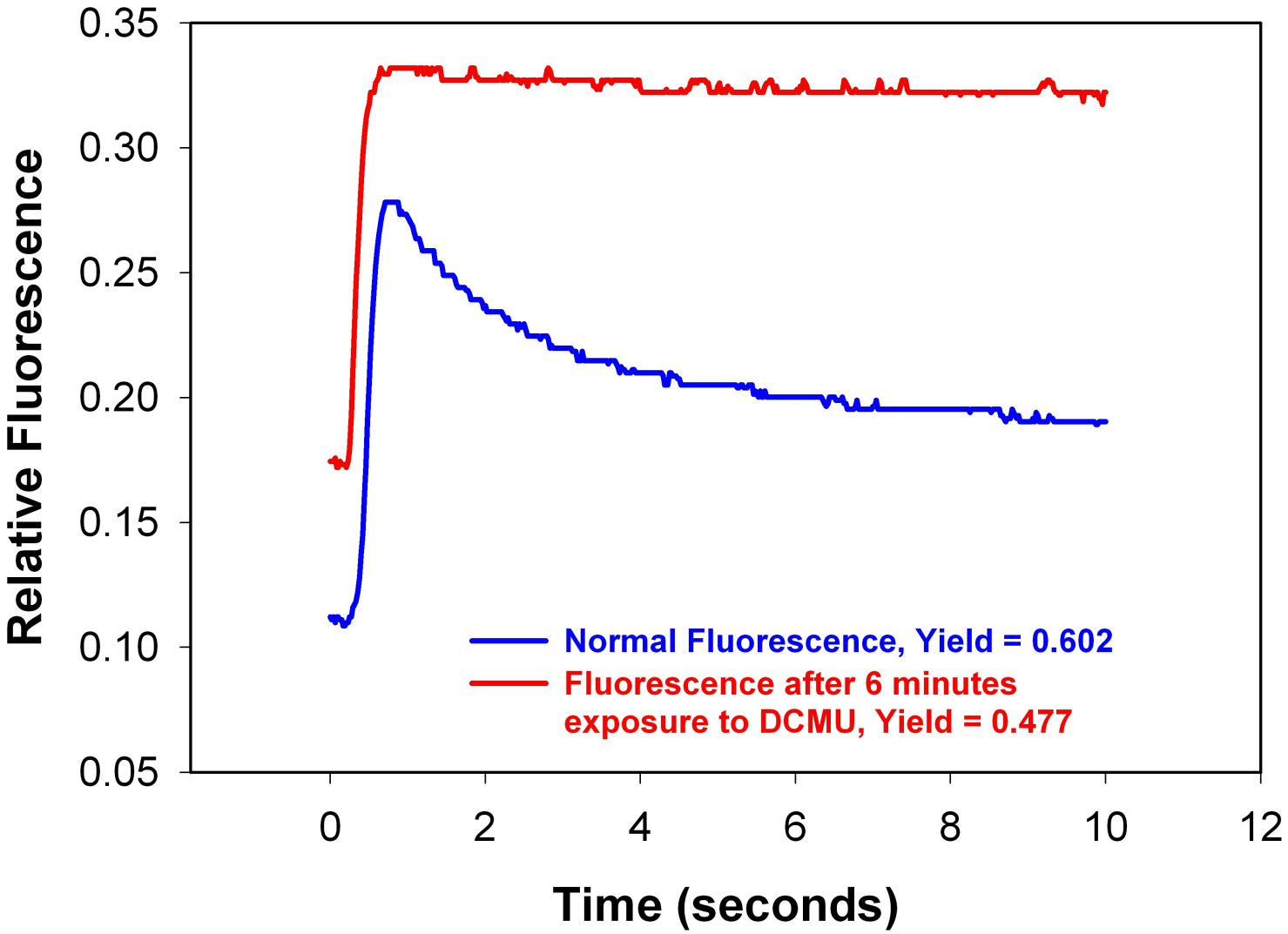
Effect of 0.1 ppm Paraquat on Clinch River's Naturally-Occurring Algae (Error Bars Represent Triplicate Experiments)

EPA Health Advisory (10-Kg Child, 1 day) = 0.1 ppm



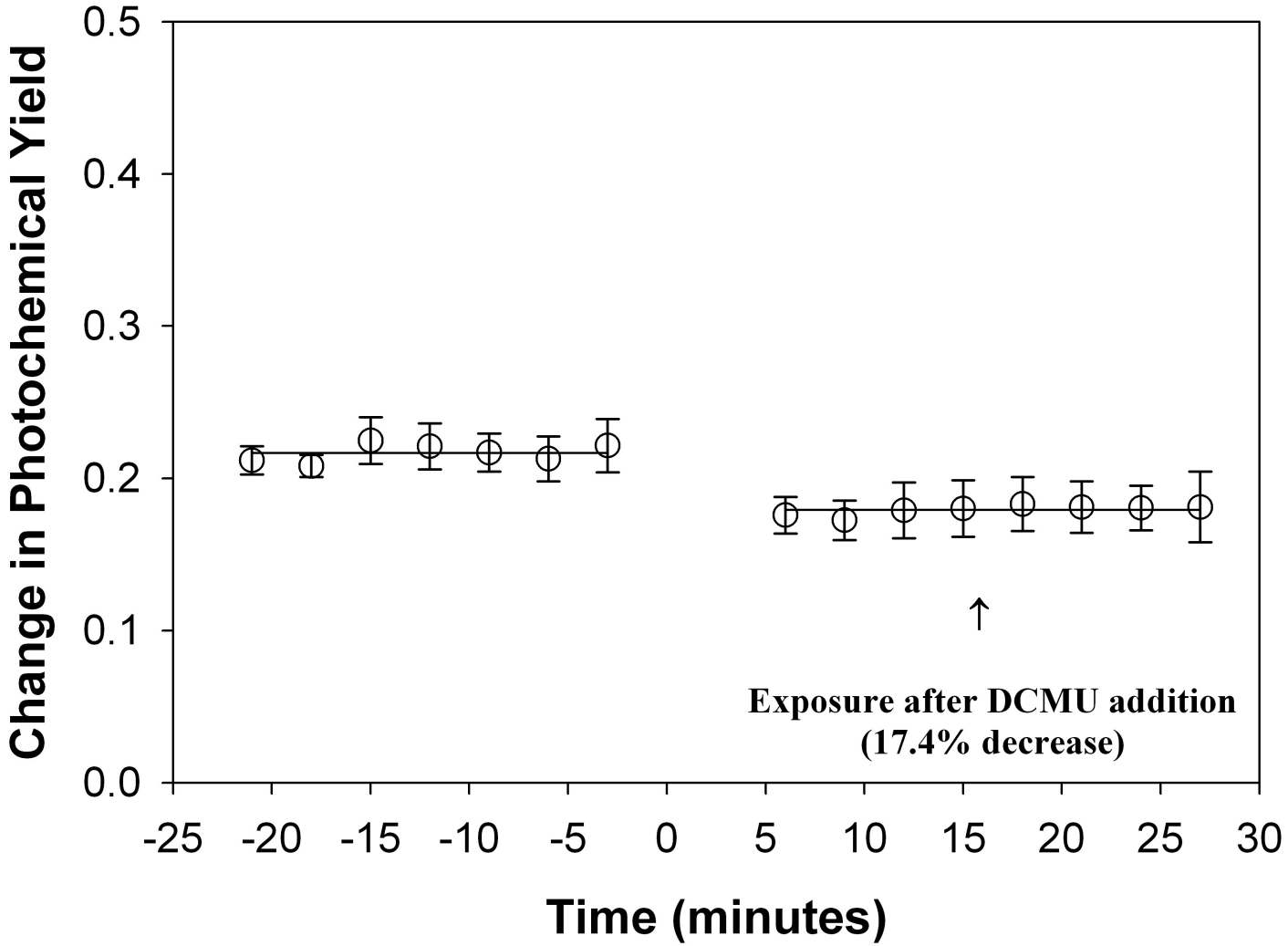
Effect of 2 ppm DCMU (Diuron) on Clinch River's Naturally-Occurring Algae

EPA Health Advisory (10-Kg Child, 1 day) = 1 ppm



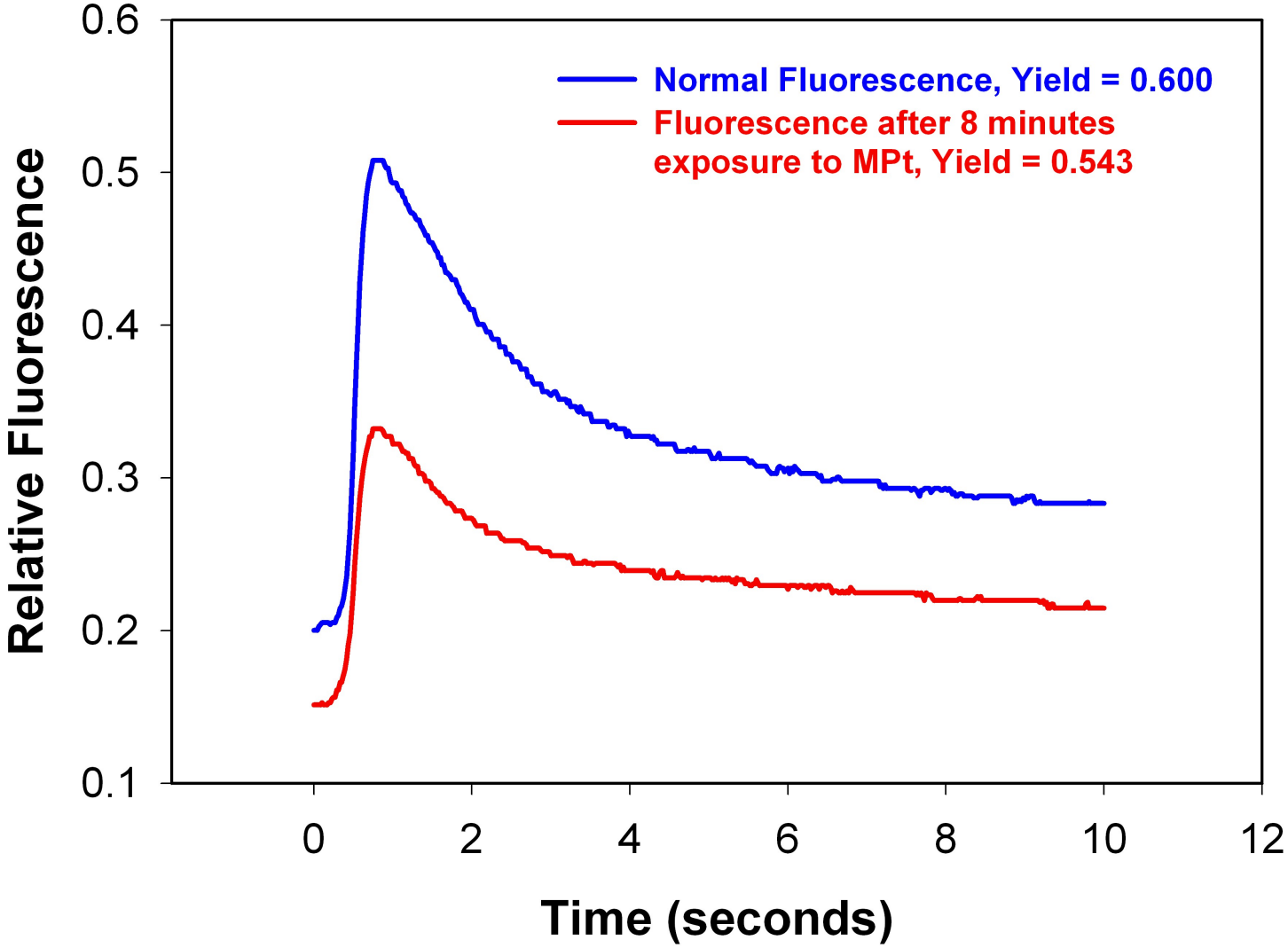
Effect of 1 ppm DCMU (Diuron) on Clinch River's Naturally-Occurring Algae (Error Bars Represent Triplicate Experiments)

EPA Health Advisory (10-Kg Child, 1 day) = 1 ppm



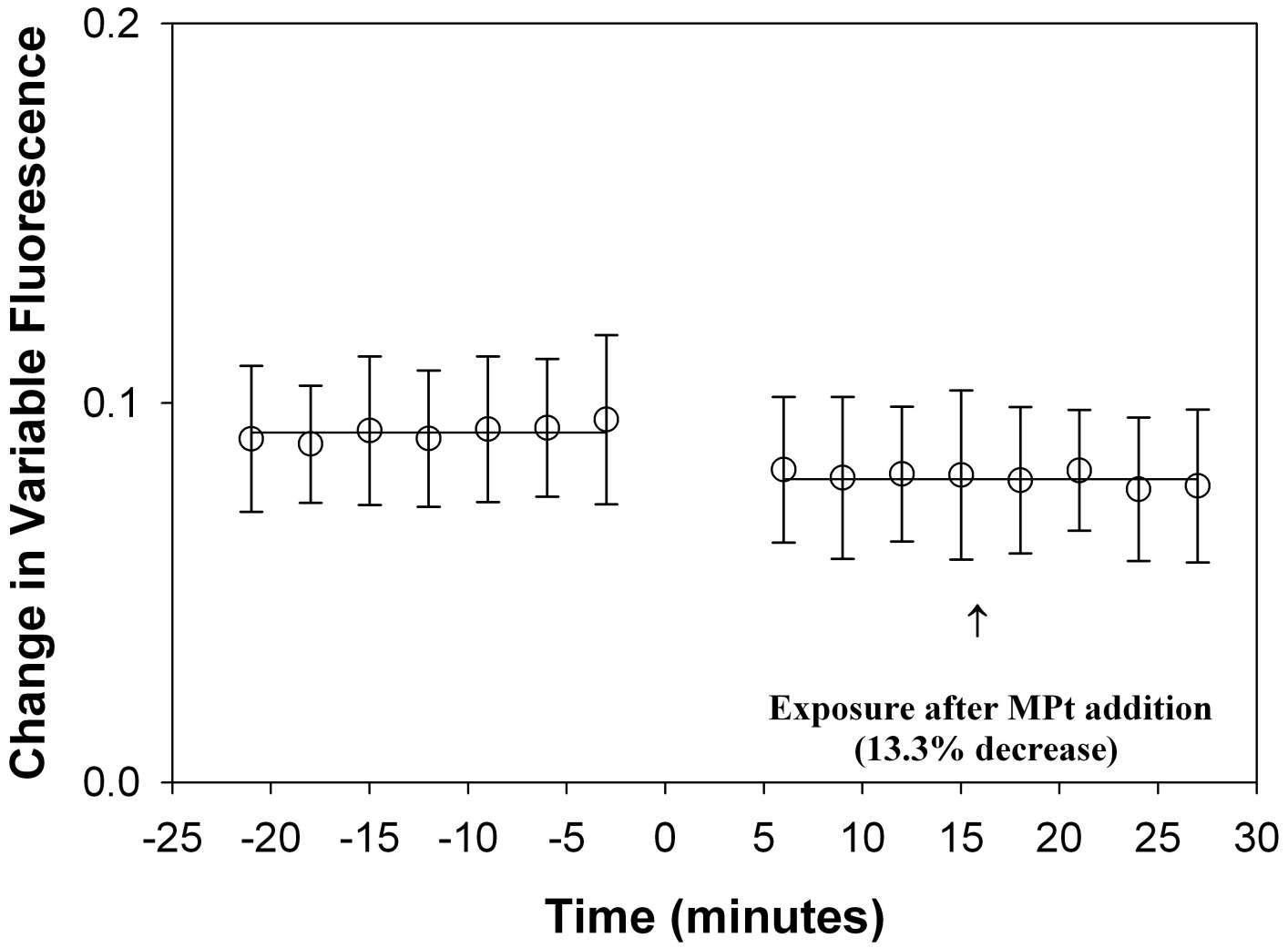
Effect of 5 ppm Methyl Parathion (MPt) on Clinch River's Naturally-Occurring Algae

EPA Health Advisory (10-Kg Child, 1 day) = 0.3 ppm



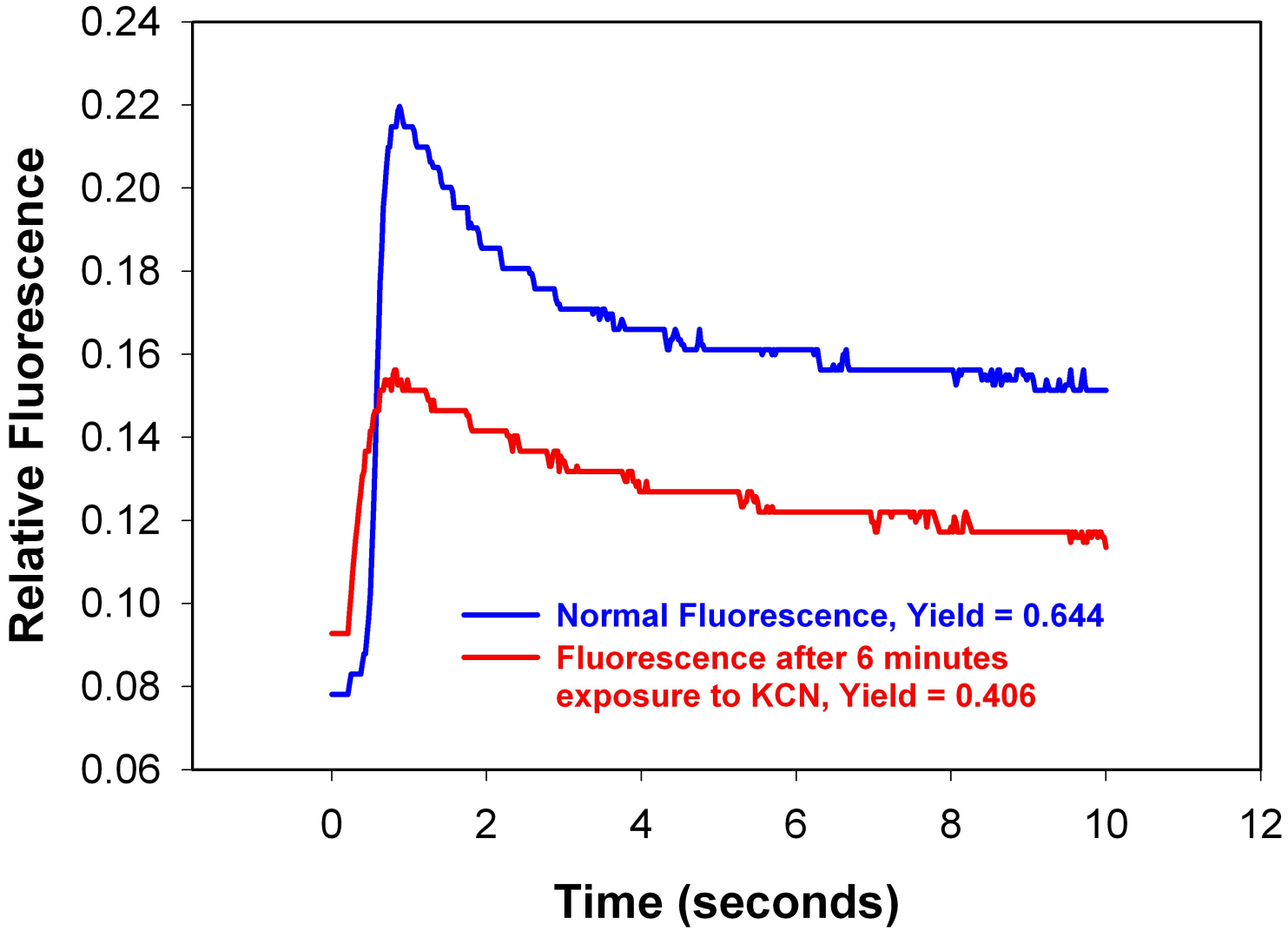
Effect of 4 ppm Methyl Parathion (MPt) on Clinch River's Naturally-Occurring Algae (Error Bars Represent Triplicate Experiments)

EPA Health Advisory (10-Kg Child, 1 day) = 0.3 ppm



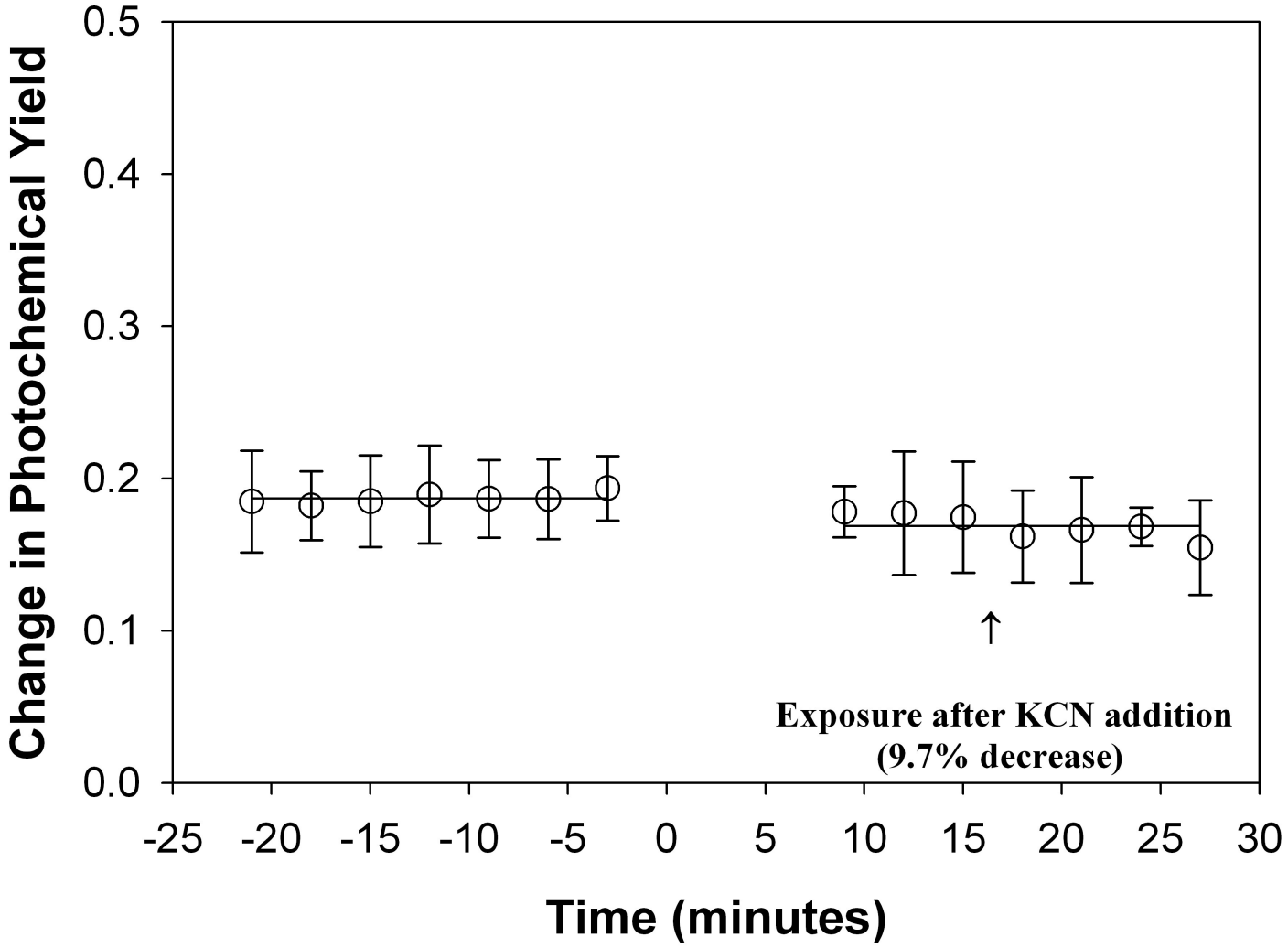
Effect of 130 ppm Potassium Cyanide (KCN) on Clinch River's Naturally-Occurring Algae

EPA Health Advisory (10-Kg Child, 1 day) = 0.2 ppm

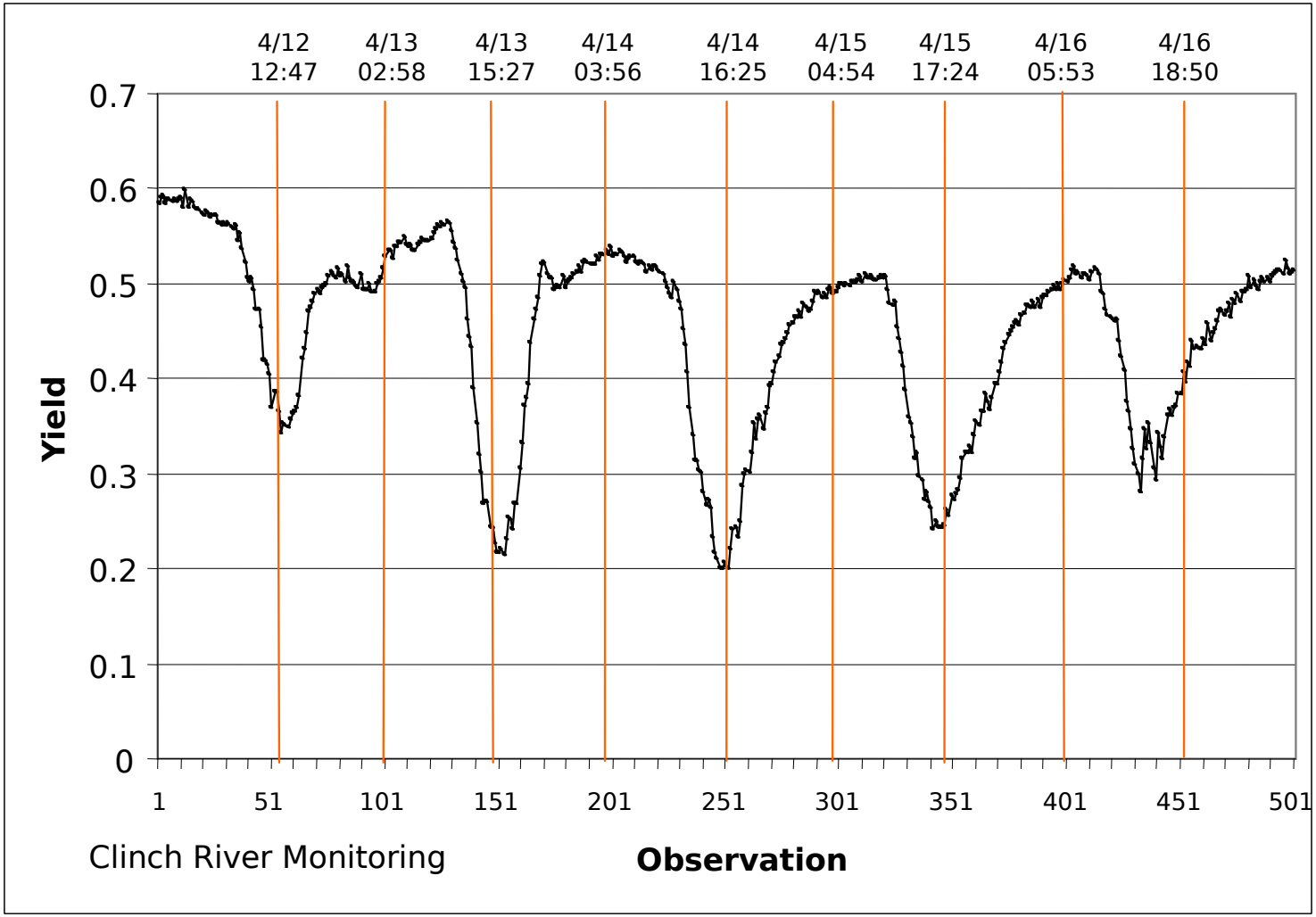


Effect of 10 ppm Potassium Cyanide (KCN) on Clinch River's Naturally-Occurring Algae (Error Bars Represent Triplicate Experiments)

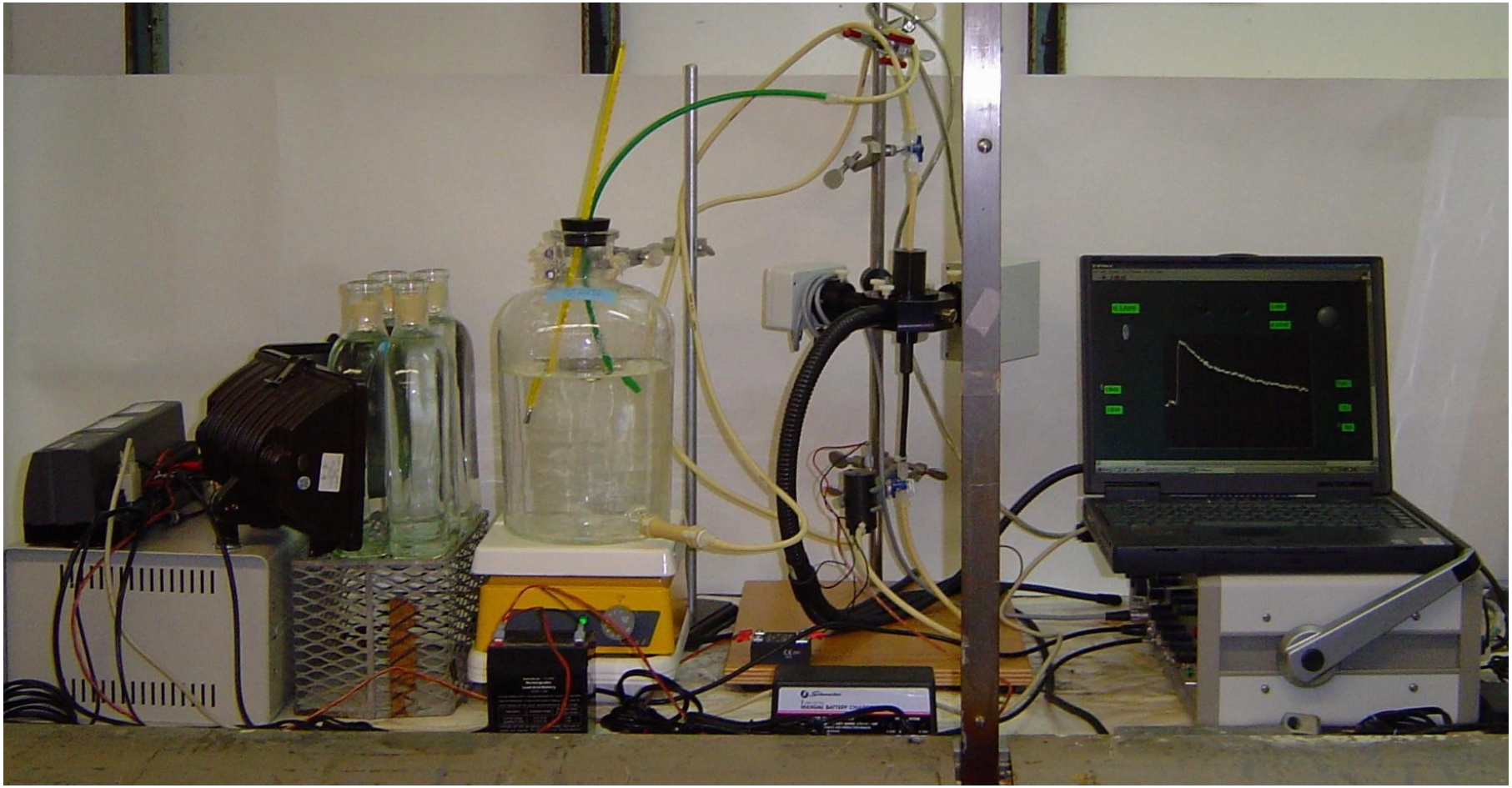
EPA Health Advisory (10-Kg Child, 1 day) = 0.2 ppm



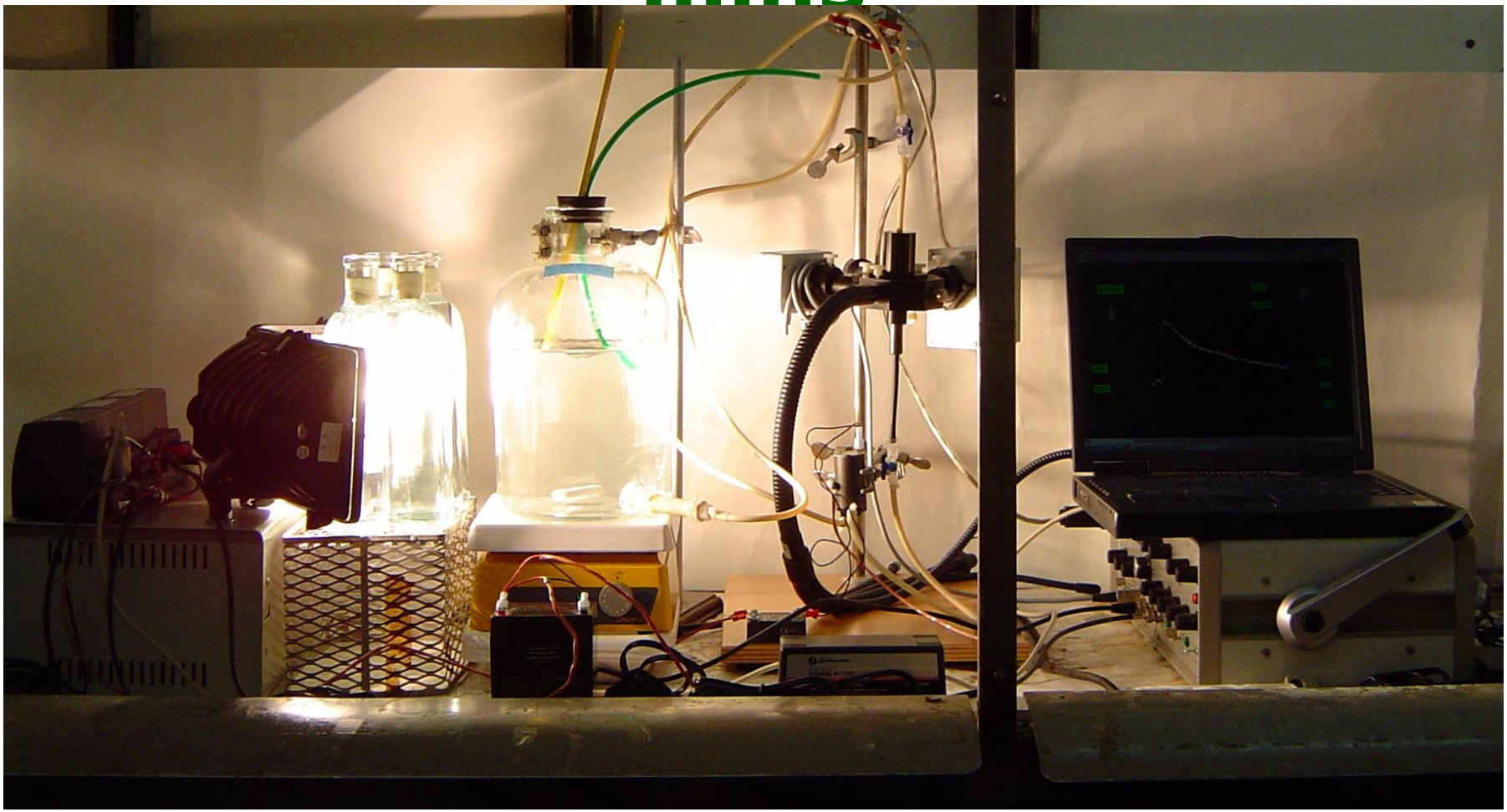
Diurnal Variation in Photosynthetic Activity



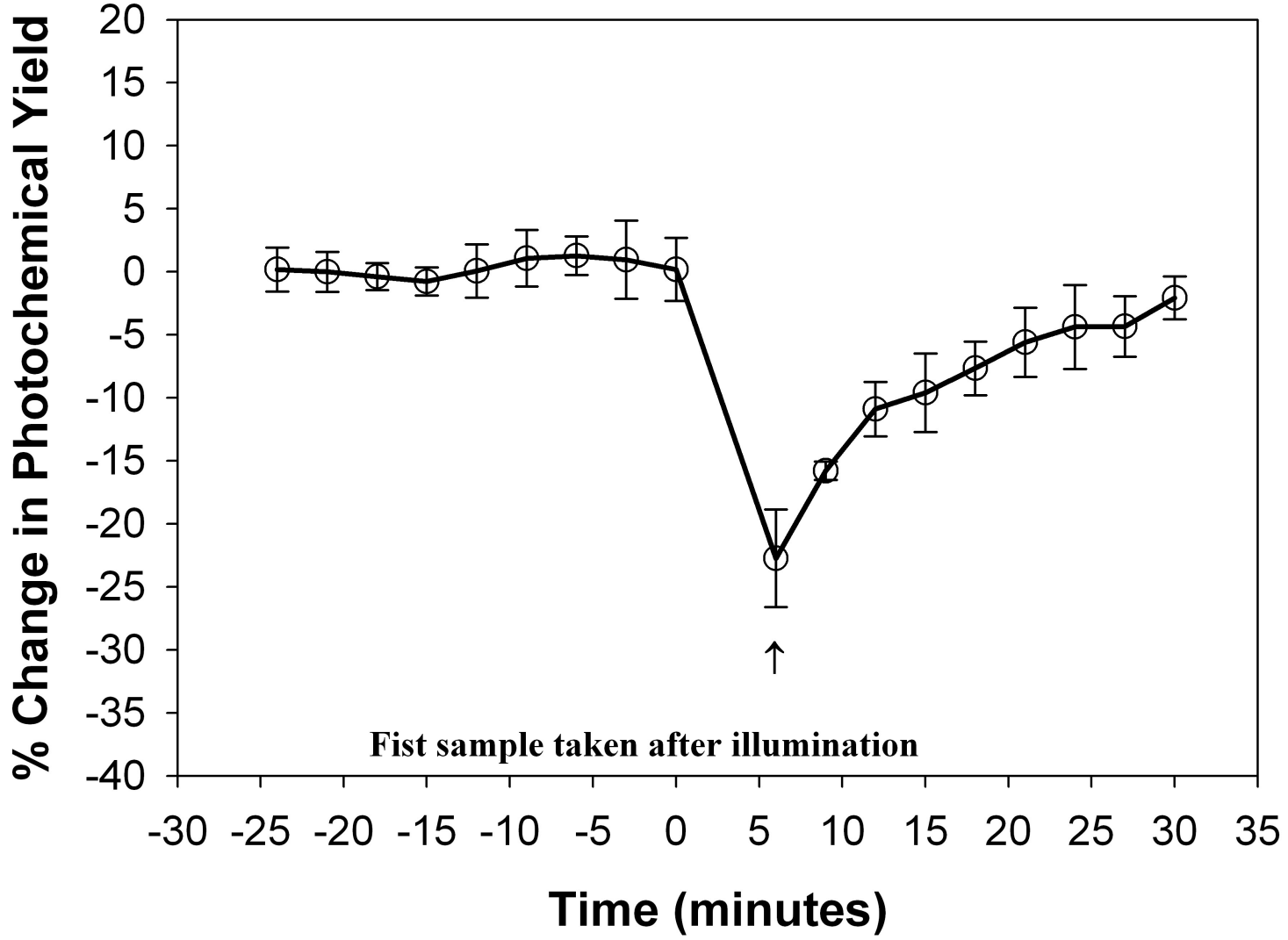
Solar Simulation Studies



Induced Photoinhibition: Average 1,500 μ*E*/m²/s for 30 mins

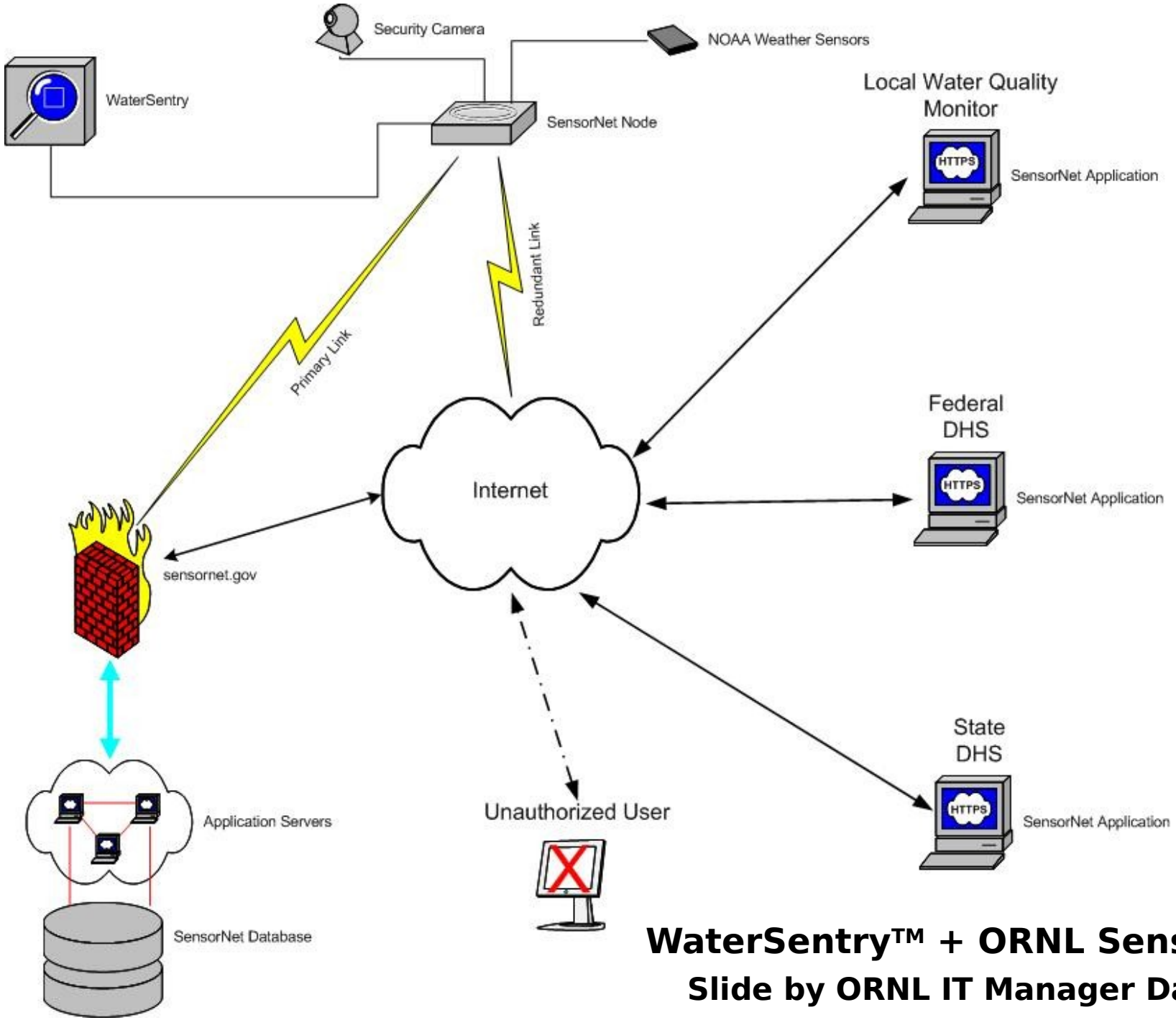


Recovery of Clinch River's Naturally-Occurring Algae from a 30-min Exposure to an Average 1,500 μ*E*/m^2/s (Error Bars Represent Triplicate Experiments)



ORNL's SensorNet

- Communications and Information Technology Infrastructure to support a National System for Comprehensive CBRNE Incident Management in Cooperation with State and Local Governments
  - Common Data Highway for a Comprehensive Set of Homeland Security Sensors
  - Distributed Access with Multi-Level Security, Information Fusion, and a Common Operational Data Base
  - Ultra-High Level of Reliability, Survivability, and Security
  - Scalability Across State, Local and Federal Governments



WaterSentry™ + ORNL SensorNet

Slide by ORNL IT Manager David E.